Fundamental Mechanics: Quiz 1

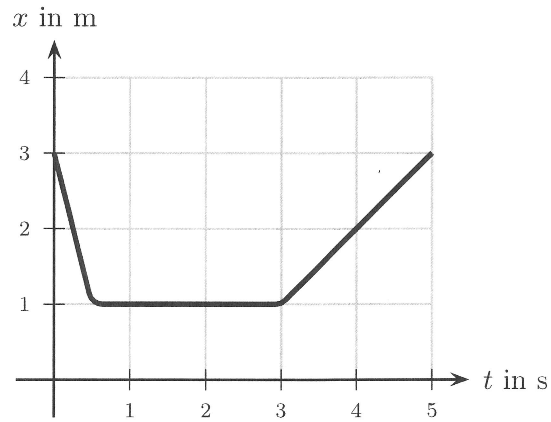
24 August 2016

Name: Taylor Larrechea **Total:** 5 /5

Formulae: $v_{\text{avg}} = \dfrac{\Delta x}{\Delta t} = \dfrac{x_f - x_i}{t_f - t_i}$ $\Delta x = v_{\text{avg}} \Delta t$ $x_f = x_i + v_{\text{avg}} \Delta t$

$v_{\text{avg}} =$ slope of position vs time

An ant walks back and forth along a straight stick. The graph of the ant's position vs. time is as illustrated. Which of the following (choose one) is true?



i) The ant's speed at $t = 1\,\text{s}$ is the same as at $t = 4\,\text{s}$ and they are both zero.

ii) The ant's speed at $t = 1\,\text{s}$ is the same as at $t = 4\,\text{s}$ and they are not both zero.

iii) The ant is moving faster at $t = 1\,\text{s}$ than at $t = 4\,\text{s}$.

iv) The ant is moving slower at $t = 1\,\text{s}$ than at $t = 4\,\text{s}$.

$t=1$ $t=4s$
$x=1$ $x=2$

Briefly explain your answer.

$\dfrac{\Delta x}{\Delta t} = \dfrac{xf - x_i}{tf - t_i}$ $\dfrac{2-1}{4-1} = \dfrac{1}{3}$

Speed at $t=1$ $= 0\,m/s$
Speed at $t=4s$ $= 1\,m/s$

Phys 131
Fall 2016

Fundamental Mechanics: Quiz 2

30 August 2016

Name: Taylor Larrechea **Total:** 0.5 /5

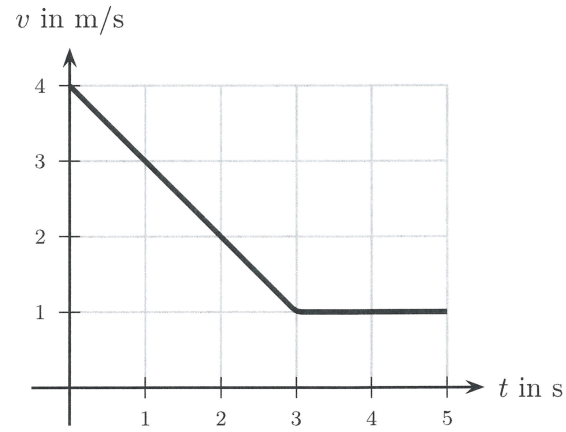
Formulae:

$$v_{\text{avg}} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i} \qquad \Delta x = v_{\text{avg}}\Delta t \qquad v_{\text{avg}} = \text{slope of position vs time}$$

$$a_{\text{avg}} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i} \qquad \Delta v = a_{\text{avg}}\Delta t \qquad a_{\text{avg}} = \text{slope of velocity vs time}$$

$$\boxed{\Delta x = \text{area under velocity vs time}}$$

An ant walks along one direction and the graph of the ant's velocity vs. time is as illustrated, starting at position $x = 10\,\text{m}$ at time $t = 0\,\text{s}$. Determine the ant's **position** and **acceleration** at $t = 2\,\text{s}$.



$x_0 = 10$

$v_0 = 4$ m/s +0.5

$v_1 = \cancel{-1}$ m/s

$v_2 = \cancel{-1}$ m/s

Position$_0$ = 10

10m

0s

$$\boxed{\begin{array}{l}\text{Position} = \cancel{8\,m}\ (-3) \\ \text{acceleration} = -1\ m/s\end{array}}$$

How did you get this from your numbers for velocity? (-1.5)

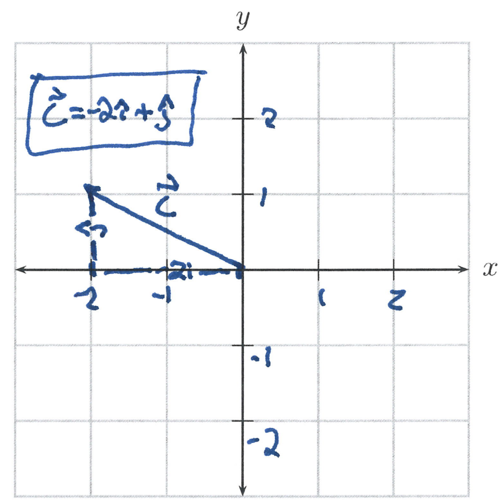
Fundamental Mechanics: Quiz 3

6 September 2016

Name: Taylor Larrechea **Total:** 5 /5

Formulae: $\sin\theta = \dfrac{\text{opp}}{\text{hyp}}$ $\cos\theta = \dfrac{\text{adj}}{\text{hyp}}$ $A = \sqrt{A_x^2 + A_y^2}$

Consider the vectors $\vec{\mathbf{A}} = -4\hat{\mathbf{i}} + 4\hat{\mathbf{j}}$ and $\vec{\mathbf{B}} = 2\hat{\mathbf{i}} - 3\hat{\mathbf{j}}$. Let $\vec{\mathbf{C}} = \vec{\mathbf{A}} + \vec{\mathbf{B}}$. Determine the **components** of $\vec{\mathbf{C}}$, **draw the vector** as accurately as possible on the coordinate axes that are provided and determine the **magnitude of** $\vec{\mathbf{C}}$.



$\vec{A} = -4\hat{i} + 4\hat{j}$ $\vec{C} = \vec{A} + \vec{B}$

$\vec{B} = 2\hat{i} - 3\hat{j}$

$\vec{A} + \vec{B} = \vec{C}$

$(-4i + 2i) + (4\hat{j} - 3\hat{j}) = \vec{C}$

$-2i + \hat{j} = \vec{C}$

$\vec{C} = -2i + \hat{j}$ Magnitude $= \sqrt{5}$

x component $= -2$ $C = \sqrt{5}$

y component $= 1$

$C = \sqrt{-2^2 + 1^2}$

$C = \sqrt{4+1}$

$C = \sqrt{5}$

Fundamental Mechanics: Quiz 4

20 September 2016

Name: Taylor Larrechea **Total:** 5/5

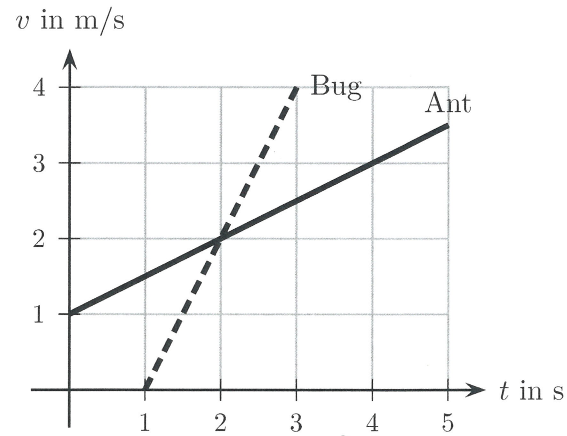
Formulae: $\vec{\mathbf{v}}_{\text{avg}} = \dfrac{\Delta \vec{\mathbf{r}}}{\Delta t}$ $\quad \vec{\mathbf{a}}_{\text{avg}} = \dfrac{\Delta \vec{\mathbf{v}}}{\Delta t}$ $\quad a =$ slope of v vs. t $\quad \vec{\mathbf{F}}_{\text{net}} = \sum \vec{\mathbf{F}}_i = m\vec{\mathbf{a}}$

An ant and a bug walk along straight wires. The graph illustrates their velocities vs. time. They have the same mass. Which of the following (choose one) is true at 2.0 s?

i) The net force on the ant is the same as on the bug.

ii) The net force on the ant is larger than the net force on the bug.

iii) The net force on the ant is smaller than the net force on the bug.



Briefly explain your answer.

$F = ma$

Slope of v vs t gives a

Bug slope at t=2

$2 = 2\,m/s^2$

Ant slope at t=2

$\frac{1}{2} = 0.5\,m/s^2$

Bug accel > Ant accel

$\therefore$ Net Force on Bug > Net force on ant

$\frac{\Delta v}{\Delta t}$

Bug $= \vec{a}_{avg} = \frac{2-0}{2-1} = 2$

Ant $= \vec{a}_{avg} = \frac{3-1}{4-0} = \frac{2}{4} = \frac{1}{2}$

$\vec{V}_{avg}$ Bug $= \vec{V}_{avg}$ Ant

$\boxed{\text{Bug accel > larger than ant}}$

$F = ma$

Fundamental Mechanics: Quiz 5

27 September 2016

Name: Taylor Larrechea **Total:** 5 /5

Formulae: $v_{fy} = v_{iy} + a_y \Delta t$ $\quad v_{fy}^2 = v_{iy}^2 + 2a_y \Delta y$ $\quad y_f = y_i + v_{iy}\Delta t + \frac{1}{2} a_y \Delta t^2$

$\vec{\mathbf{F}}_{net} = \sum \vec{\mathbf{F}}_i = m\vec{\mathbf{a}}$ $\quad F_G = mg$ $\quad g = 9.80\,\mathrm{m/s^2}$

$f_k = \mu_k n$ $\quad f_s \leqslant \mu_s n$

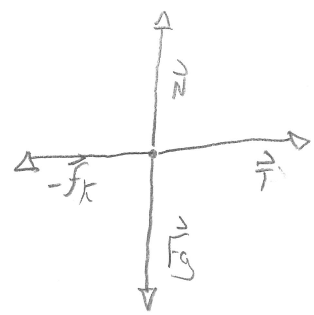
A 200 kg crate lies on a horizontal floor and is pulled by a rope which is horizontal. The crate slides in a straight line with a constant speed of 5.0 m/s. The coefficient of kinetic friction between these surfaces is 0.65 and the coefficient of static friction is 0.75. Determine the tension in the rope.

$m = 200\ \mathrm{kg}$

$V = 5.0\ \mathrm{m/s}$

$\mu_K = 0.65$

$\mu_S = 0.75$



$\Sigma_x = \vec{T} - \vec{f}_K = 0$

$\vec{T} = \vec{f}_K$

$\Sigma_y = N - mg = 0$

$N = mg$

f	x	x
$\vec{T}$	$\vec{T}$	0
$-\vec{f}_K$	$-\vec{f}_K$	0
$\vec{F}_g$	0	$-mg$
$\vec{N}$	0	N

$\mu_K(N) = \text{kinetic}$

$\mu_K(1960\ N) = \text{Kintetic}$

$\mu_K = 0.65$

$\vec{N} = mg$

$\vec{N} = (200\ \mathrm{kg})(9.8\ \mathrm{m/s^2})$

$\vec{N} = 1960\ N$

$0.65(1960N) = 1274$

$\vec{f}_K = 1274\ N$

$\vec{f}_K = \vec{T}$

$1274\ N = \vec{T}$

$\boxed{\vec{T} = 1274\ N}$

Phys 131
Fall 2016

Fundamental Mechanics: Quiz 6

4 October 2016

Name: Taylor Larrechea **Total:** 5 /5

Formulae: $\vec{\mathbf{F}}_{\text{net}} = \sum \vec{\mathbf{F}}_i = m\vec{\mathbf{a}}$ $\quad F_{\text{g}} = mg$ $\quad g = 9.80\,\text{m/s}^2$

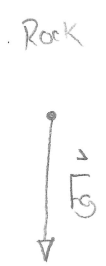
$f_{\text{k}} = \mu_k n$ $\quad f_{\text{s}} \leqslant \mu_s n$

A rock, whose mass is much less that that of the Earth, falls freely toward the surface of the Earth. Ignore air resistance and all other objects in the vicinity of Earth.

a) Is the force exerted by the rock on the Earth smaller than, larger than or equal to the force exerted by the Earth on the rock?

b) Is the acceleration of the rock smaller than, larger than or equal to the acceleration of Earth?

Explain your answers.



a.) The Force of the rock on the earth is equal to the Force of the ~~Earth~~ Earth on the rock because of Newtons third law.

b.) Since $F = ma$, and the mass of the rock is much Smaller than the Earths, the rock would require a larger acceleration For the forces to be equal

object is falling

$\sum F_y = ma$

$\vec{F_g} = ma$

$m_{Rock}\, g = m a$

Phys 131
Fall 2016

Fundamental Mechanics: Quiz 7

17 October 2016

Name: Taylor Larrechea **Total:** 5 /5

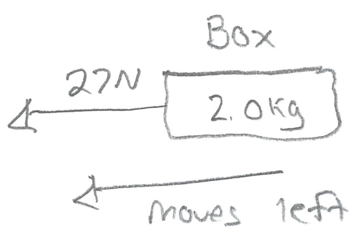
Formulae: $K = \frac{1}{2}mv^2$ $\quad W = F\Delta r \cos\theta$ $\quad W_{\text{net}} = \Delta K$ $\quad g = 9.80\,\text{m/s}^2$

A 2.0 kg box is initially at rest on a horizontal frictionless floor. Subsequently a rope pulls horizontally to the left with a constant force of 27 N and the box moves 3.0 m. Determine the work done by the rope, the work done by gravity and the work done by the normal force. Determine the speed of the box after it has moved 3.0 m from its starting point.

$M = 2.0\,kg$

$F = 27\,N$

$\Delta r = 3.0\,m$



$\Sigma_y = 0$

$\vec{N} - mg = 0$

$\vec{N} = mg$

$F = 27N$

$\vec{N} = 19.6N$

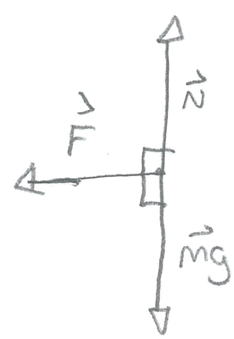
$\vec{F_g} = 19.6N$

$W = F\Delta r \cos\theta$

Rope $\quad \theta = 0$

$W = 27N(3.0m)\cos 0$

Rope $= \boxed{81\,J}$



$t_0 = 0s \quad t_1 =$

$x_0 = 0m \quad x_1 = 3m$

$v_0 = \quad v_1 =$

$a_x = \quad a_x$

Normal Force $\quad \vec{N} = 19.6N$

$W = F\Delta r \cos\theta$

$W = 19.6N(3.0m)\cos(90)$

Normal $= \boxed{0J}$

$27N = 2.0kg(a)$

$a = 13.5\,m/s^2$

$\Delta x = 3.0m$

$v_1^2 = v_0^2 + 2a\Delta x$

$v_1^2 = 81$

$v_1 = 9$

Velocity after 3.0m $\quad v_1 = 9\,m/s$

Gravity Force $\quad mg = 19.6N$

$W = F\Delta r \cos\theta \quad \theta = 90$

$W = 19.6N(3.0m)\cos(90)$

Gravity $= \boxed{0J}$

Fundamental Mechanics: Quiz 8

25 October 2016

Name: Taylor Larrechea **Total:** 5 /5

Formulae: $K = \frac{1}{2}mv^2$ $W = \vec{\mathbf{F}} \cdot \Delta\vec{\mathbf{r}} = F\Delta r\cos\theta$ $W_{\text{net}} = \Delta K$ $g = 9.80\,\text{m/s}^2$

$F_{\text{spring}} = -k\Delta s$ $W_{\text{spring}} = -\frac{1}{2}k(\Delta s_f)^2 + \frac{1}{2}k(\Delta s_i)^2$ $P = \frac{W}{\Delta t}$

A 40 kg crate is lifted vertically by a rope and moves up at a constant speed. The motor which pulls the rope provides power of 800 W. Determine the **work done by the rope** in 5.0 s and use the result to determine **how high the crate is lifted** in that time.

$\Sigma_y = 0$

$\vec{T} - mg = 0$

$\vec{T} = mg$

$\vec{T} = 40\,kg \cdot 9.8\,m/s^2$

$\vec{T} = 392\,N$

$Power = \frac{work}{Time}$

$800\,W = \frac{W}{5.0\,s}$

$W = 4000\,J/s$

$W = \vec{F} \cdot \Delta r$ $\vec{F} = 392\,N$

$4000\,J/s = 392\,N \cdot \Delta r$ $W = 4000\,W$

$\frac{4000\,J/s}{392\,N} = \Delta r$

$\Delta r = 10.2\,m$

Phys 131
Fall 2016

Fundamental Mechanics: Quiz 9

1 November 2016

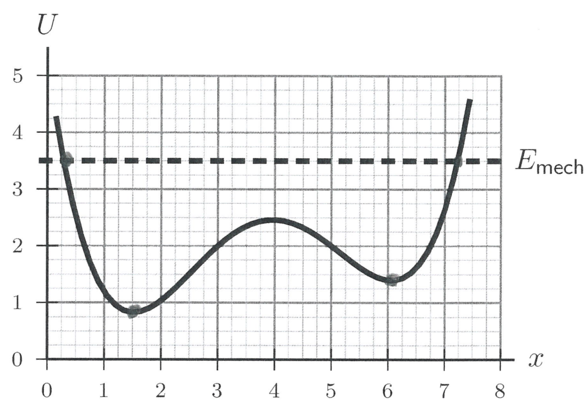
Name: Taylor Larrechea **Total:** 1.5 /5

Formulae: $K = \frac{1}{2}mv^2$ $W = \vec{\mathbf{F}} \cdot \Delta\vec{\mathbf{r}} = F\Delta r\cos\theta$ $W_{\text{net}} = \Delta K$ $g = 9.80\,\text{m/s}^2$

$U_{\text{g}} = mgy$ $U_{\text{spring}} = \frac{1}{2}k(\Delta s)^2$ $E = K + U_{\text{g}} + U_{\text{spring}}$ $\Delta E = W_{\text{nc}}$

$F_x = -\frac{dU}{dx}$

A particle with the illustrated total mechanical energy moves subject to the illustrated potential. Indicate the locations at which the **speed is a maximum** and **the force on the particle is zero**.



At spots x= 1.5 and ~~x= 6~~ (-0.5) the speeds are maximums because this is where all of the energy is kinetic with no potential.

~~Where x=0.25 and x=7.25 is where the force is 0 because all of the energy is potential,~~

(-3)

F = slope....

Phys 131
Fall 2016

Fundamental Mechanics: Quiz 10

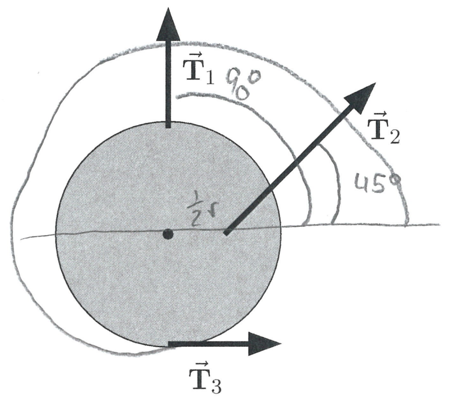
15 November 2016

Name: Taylor Larrechea **Total:** 3.5 /5

Formulae: $\Delta s = r\Delta\theta$ $\omega = \frac{d\theta}{dt}$ $\alpha = \frac{d\omega}{dt}$ $v_t = \omega r$ $a_t = \alpha r$ $g = 9.80\,\mathrm{m/s^2}$

$x_{\mathrm{cm}} = \frac{\Sigma x_i m_i}{\Sigma m_j}$ $y_{\mathrm{cm}} = \frac{\Sigma y_i m_i}{\Sigma m_j}$ $I = \Sigma m_i r_i^2$ $\tau = rF\sin\phi$

A disk with radius R can rotate about an axle through its center. Three ropes are attached to various points on the disk and pull as indicated. The magnitudes of the tensions are: $T_1 = 100\,\mathrm{N}, T_2 = 150\,\mathrm{N}$, and $T_3 = 80\,\mathrm{N}$. The angle between $\vec{\mathbf{T}}_2$ and the horizontal is 45°. Rank the torques (about the center of the disk) in order of increasing magnitude.



$\tau = rF\sin\theta$

$T_1\ \theta = \cancel{9}0°$ (0.5)

$T_2\ \theta = \cancel{45}$ ~~.45~~

$T_1 > T_2 > T_3$

Smallest to greatest

$\tau_1 = rF\sin 90$

$\tau_2 = \frac{1}{2}rF\sin 45°$

$T_3 = ??$ (−1)

$\tau_3 < \tau_2 < \tau_1$

Phys 131
Fall 2016

Fundamental Mechanics: Quiz 11

29 November 2016

Name: Taylor Larrechea **Total:** 5 /5

Formulae: $\Delta s = r\Delta\theta$ $\omega = \frac{d\theta}{dt}$ $\alpha = \frac{d\omega}{dt}$ $a_t = \alpha r$ $v_t = \omega r$

$\Delta\theta = \omega_i \Delta t + \frac{1}{2}\alpha(\Delta t)^2$ $\omega_f = \omega_i + \alpha\Delta t$ $\omega_f^2 = \omega_i^2 + 2\alpha\Delta\theta$

$\tau = rF\sin\phi$ $\tau_{\text{net}} = I\alpha$ $K_{\text{trans}} = \frac{1}{2}mv^2$ $K_{\text{rot}} = \frac{1}{2}I\omega^2$

$I = \sum_i m_i r_i^2$ (point masses) $I = MR^2$ (hoop) $I = \frac{1}{2}MR^2$ (disk)

A 4.0 kg solid disk with radius 0.40 m rotates counterclockwise about an axle through its center with angular velocity 50 rad/s. Subsequently a friction force acts at the edge of the disk and brings the disk to a stop in 5.0 s. Determine the magnitude of the friction force.

$I = \frac{1}{2}mr^2$ $R = 0.40\,m$ $M = 4.0\,kg$

$\tau = I\alpha$

$FR = I\alpha$

$\omega_i = 50\,rad/s$

$\omega_f = 0\,rad/s$

$\alpha = -10\,rad/s^2$

$\omega_f = \omega_i + \alpha\Delta t$

$0 = 50\,rad/s + \alpha(5.0s)$

$-50\,rad/s = \alpha(5.0s)$

$\alpha = -10\,rad/s^2$

$\tau = I\alpha$

$FR = (\frac{1}{2}mr^2)\alpha$

$F = \frac{1}{R}(\frac{1}{2}mr^2)\alpha$

$F = \frac{1}{(0.40m)}(\frac{1}{2}(4.0\,kg)(0.40\,m)^2)(-10\,rad/s^2)$

$F = 2.5m(0.32\,kg\cdot m^2)(-10\,rad/s)$

$F = -8\,N$

Magnitude of force ; $F = 8\,N$

Fundamental Mechanics: Quiz 12

6 December 2016

Name: Taylor Larrechea **Total:** 5 /5

Formulae: $\omega = \frac{d\theta}{dt}$ $\alpha = \frac{d\omega}{dt}$ $\tau = rF\sin\phi$ $\tau_{\text{net}} = I\alpha$ $L = I\omega$

$I = \sum_i m_i r_i^2$ (point masses) $I = MR^2$ (hoop) $I = \frac{1}{2}MR^2$ (disk)

$\vec{\mathbf{F}} = m\vec{\mathbf{a}}$ $F_{1 \text{ on } 2} = G\frac{m_1 m_2}{r^2}$ $G = 6.67 \times 10^{-11}\,\text{Nm}^2/\text{kg}^2$

A 16 kg disk with radius 0.50 m rotates counterclockwise about a frictionless axle (the axle is vertical) at a rate of 30 rad/s. A 12 kg lead brick is dropped vertically onto the disk and sticks at a point halfway from the axle to the edge of the disk. Determine the angular velocity of the disk after the brick sticks (assume that the brick is a point particle).

$L_i = L_f$ $L_i = I\omega_i$

$L_f = (I_T + I_B)\omega_f$

$\omega_f = \dfrac{L_i}{(I_T + I_B)}$

$\omega_f = \dfrac{60\text{ rad/s}\cdot\text{kg}\cdot\text{m}^2}{(2\text{ kg}\cdot\text{m}^2 + 0.75\text{ kg}\cdot\text{m}^2)}$

$\omega_f = 21.82$ rad/s

$I = \frac{1}{2}mr^2$

$= \frac{1}{2}(16\text{ kg})(0.50\text{m})^2$

$I = 2\text{ kg}\cdot\text{m}^2$

$\omega_i = 30$ rad/s

$I_B = mr^2$ $r = 0.25$ m

$m = 12$ kg

$= (12\text{ kg})(0.25\text{m})^2$

$I_B = 0.75\text{ kg}\cdot\text{m}^2$